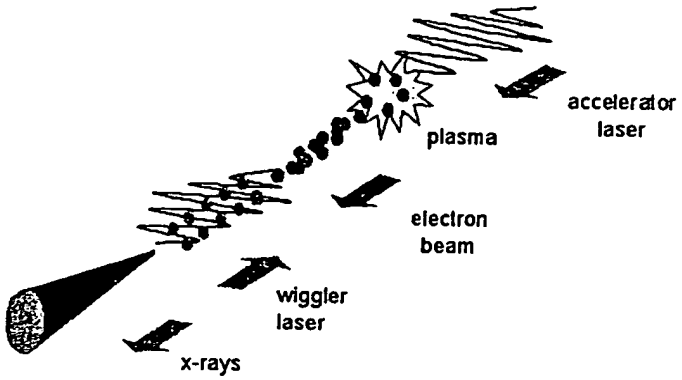



FIGURE 1. Schematic diagram illustrating the underlying physical mechanism.

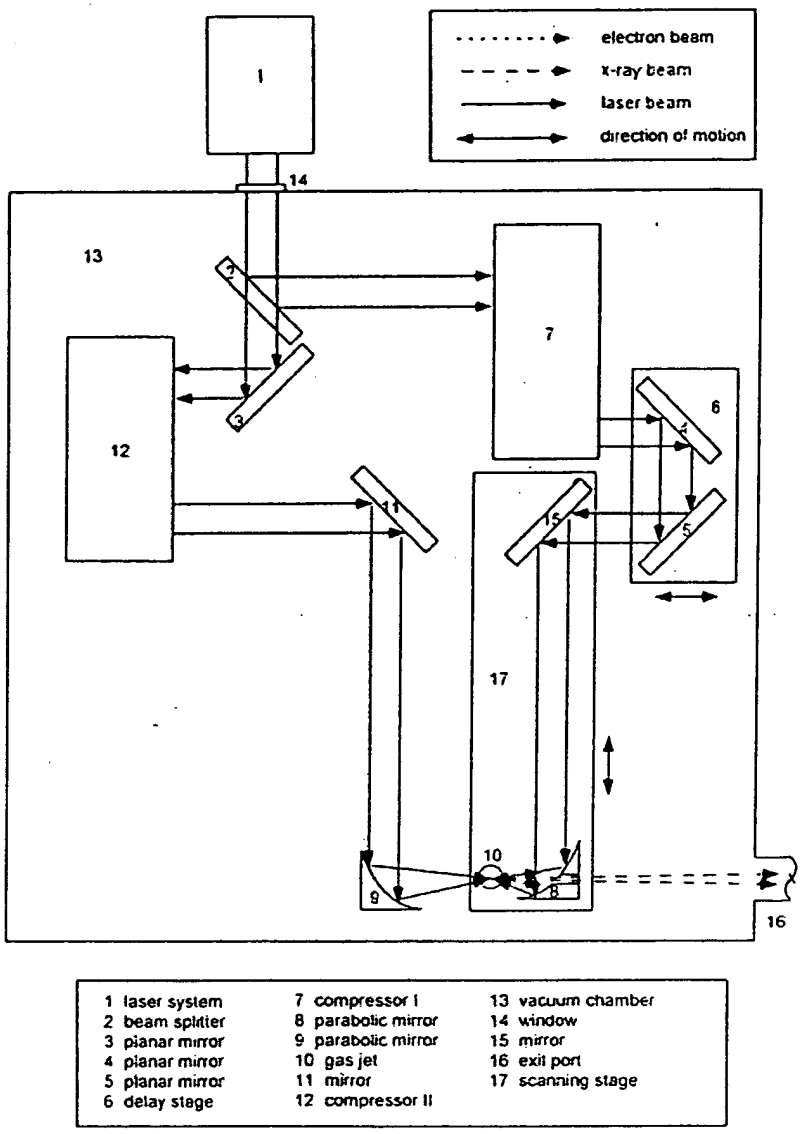



FIGURE 2. In this geometry, no electrostatic or magnetostatic filtering is employed, but the electron energy spread may be reduced by use of multiple laser beams or a density discontinuity to inject electrons at a prescribed phase.

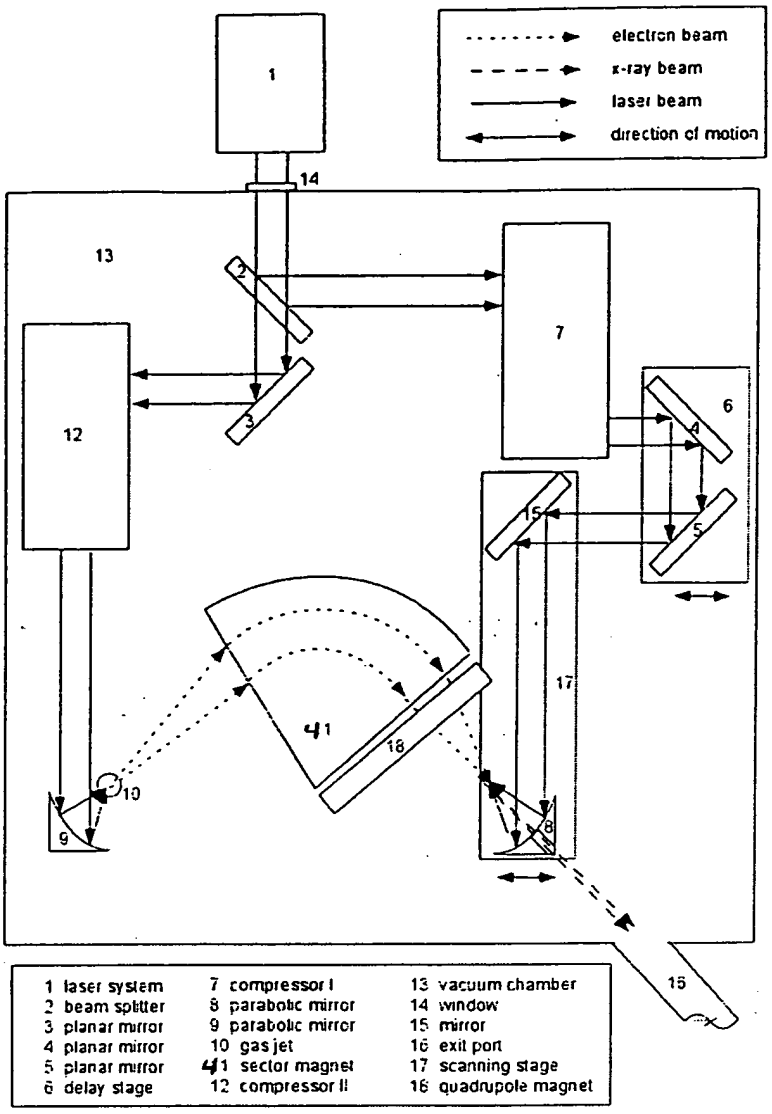



FIGURE 3. DQ configuration. A sector magnet is used in conjunction with a quadrupole to reduce the energy spread of the electron beam.

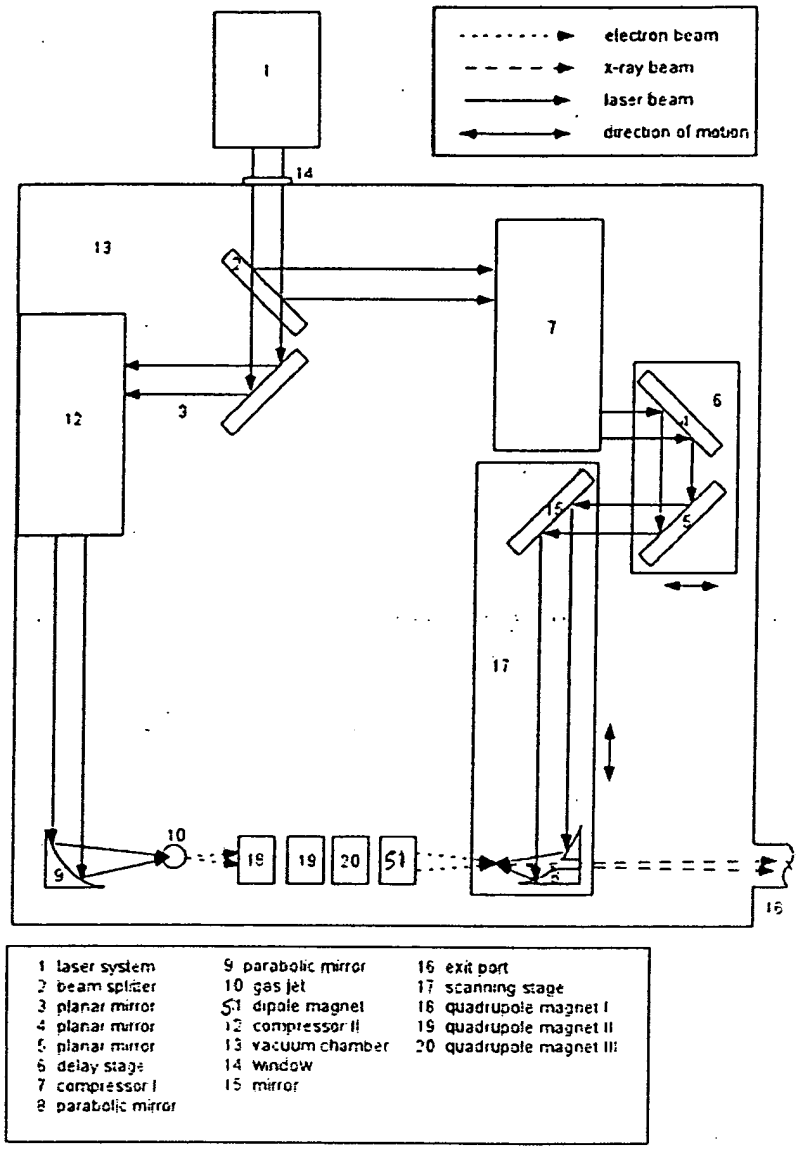



FIGURE 4. QQQD configuration. In this case, the energy spread of the electron beam is reduced and the electron source is imaged to the interaction region by use of three quadrupole magnets followed by a dipole.

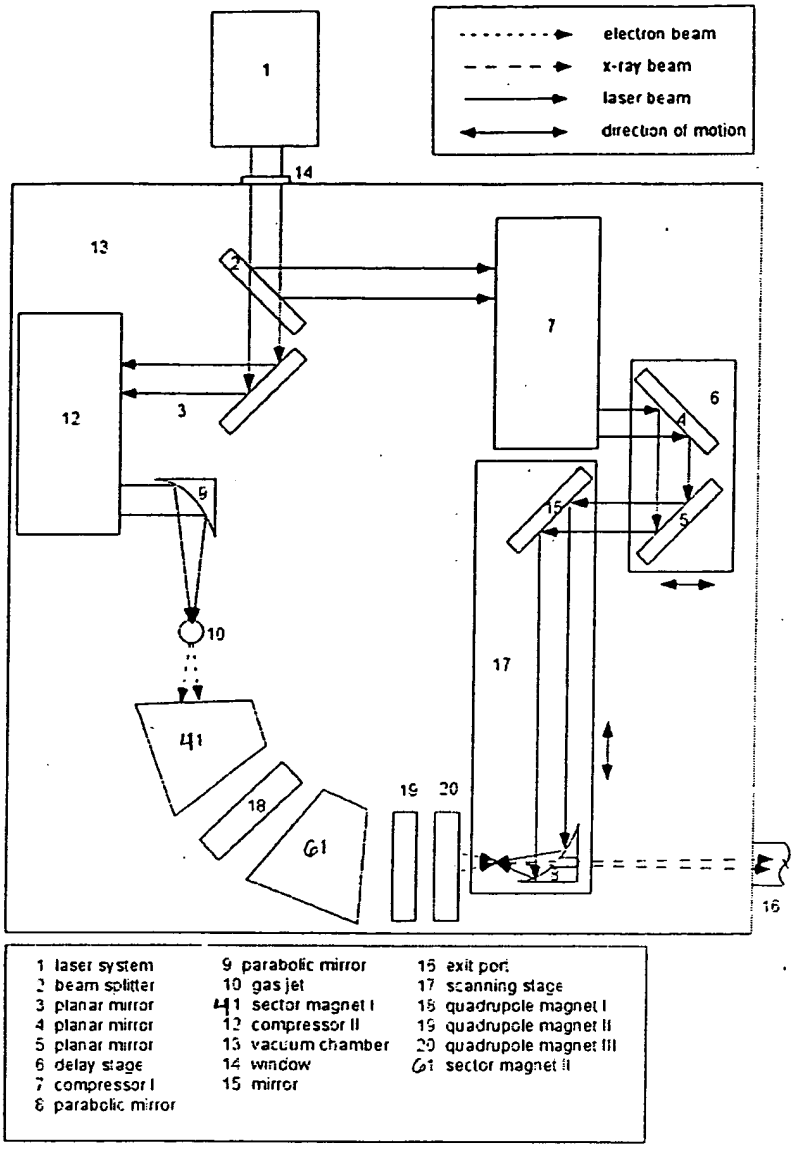
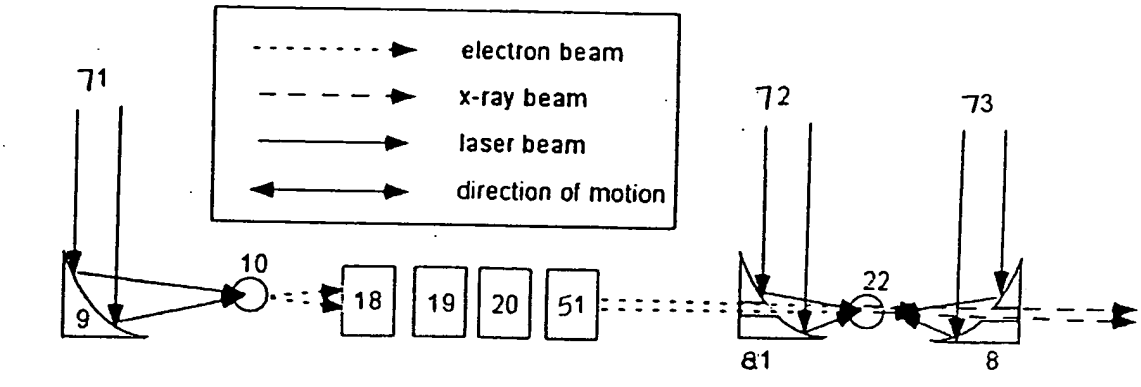



FIGURE 5. DQDQQ configuration. In this case, the energy spread of the electron beam is reduced and the electron source is imaged to the interaction region by use of a quadrupole magnet between two dipoles followed by two more quadrupoles.




| | | |
|---|---|---|
| 71 electron pump laser | 9 parabolic mirror | 22 gas jet |
| 72 harmonics pump laser | 10 gas jet | 18 quadrupole magnet I |
| 73 amplifier pump laser | 51 dipole magnet | 19 quadrupole magnet II |
| 8 parabolic mirror | 81 parabolic mirror | 20 quadrupole magnet III |

FIGURE 6. Oscillator-amplifier configuration. The components are the same as in Fig. 4, but another synchronized laser beam has been added, a harmonics pump laser beam (72), which is split off with a beam splitter and independently delayed by a delay line in similar fashion to the amplifier pump beam. (The optics used to split the beam and delay it, along with those used to do the same for the other two laser beams from Fig. 4 are not shown.) This beam is focused to a gas jet (22) by a parabolic mirror (81) with a hole in it, through which the electron beam passes. The radiation from the gas jet seeds the amplifier. The same QQQD configuration of Fig. 4 is used to reduce the energy spread of the electrons, but only the dipole magnet (51) is shown.

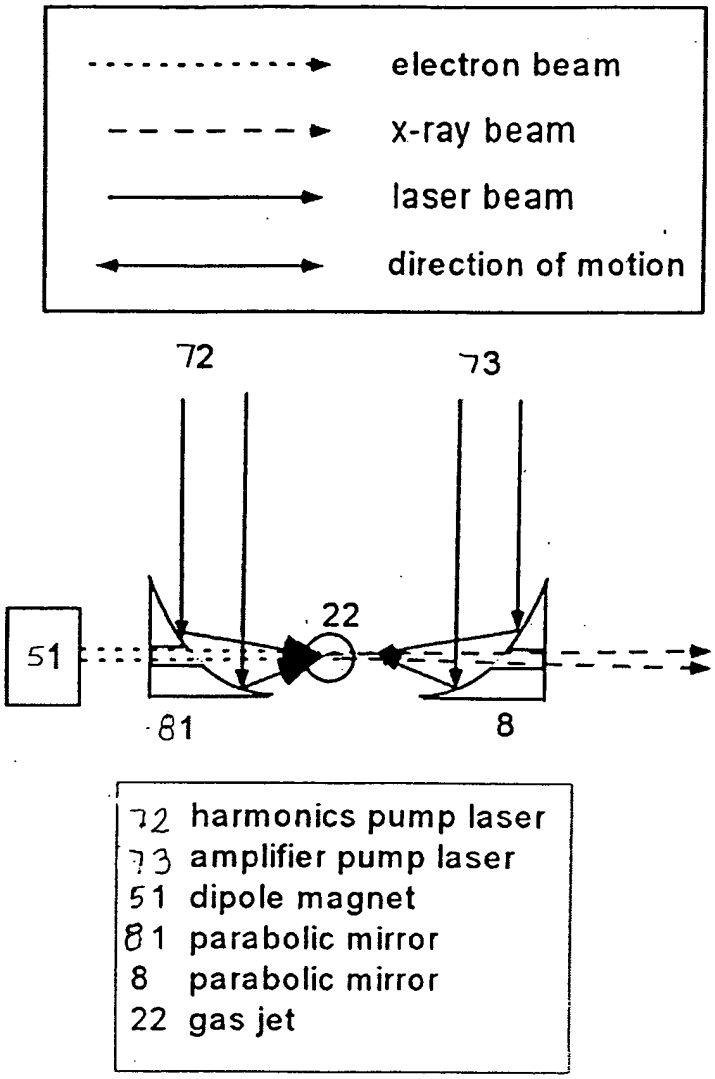



FIGURE 7. Oscillator-amplifier configuration (enlarged). This figure shows an enlarged version of final optics from Fig. 6.

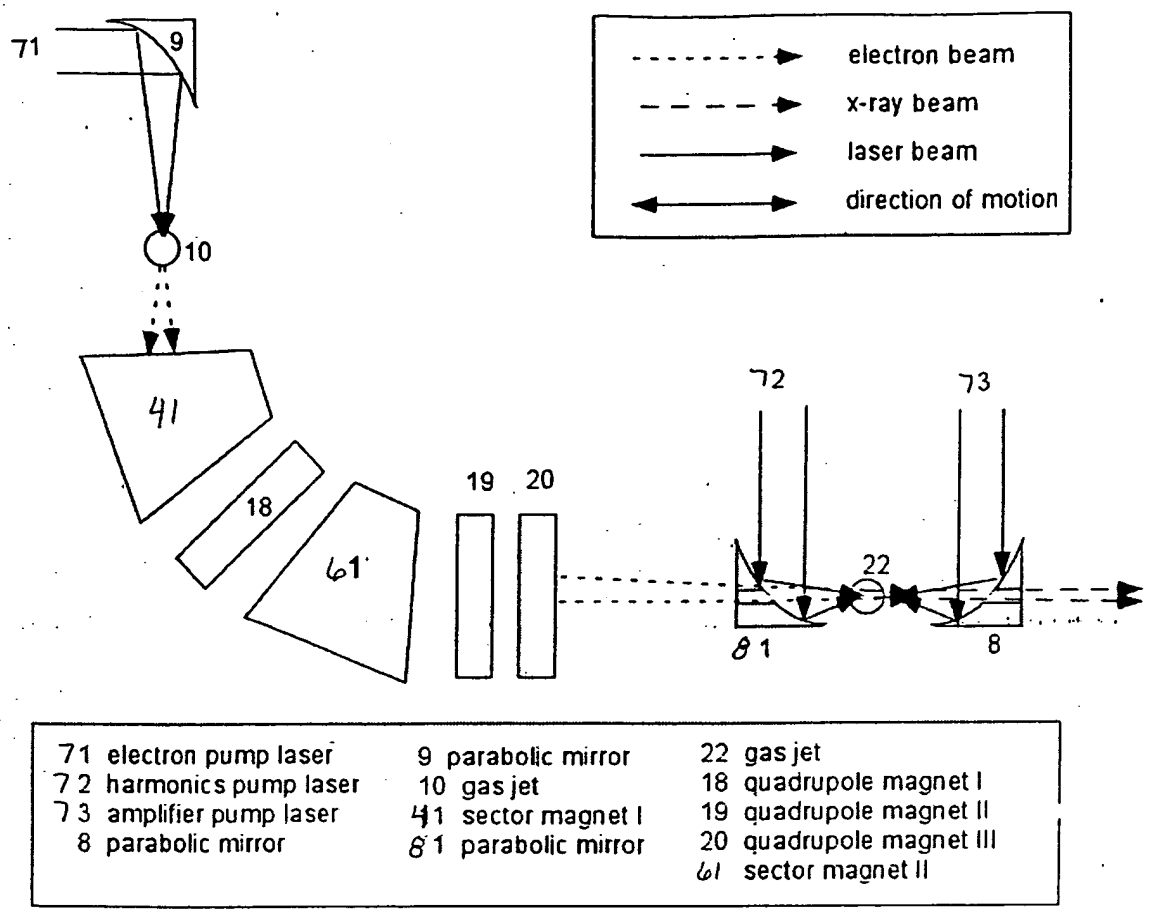
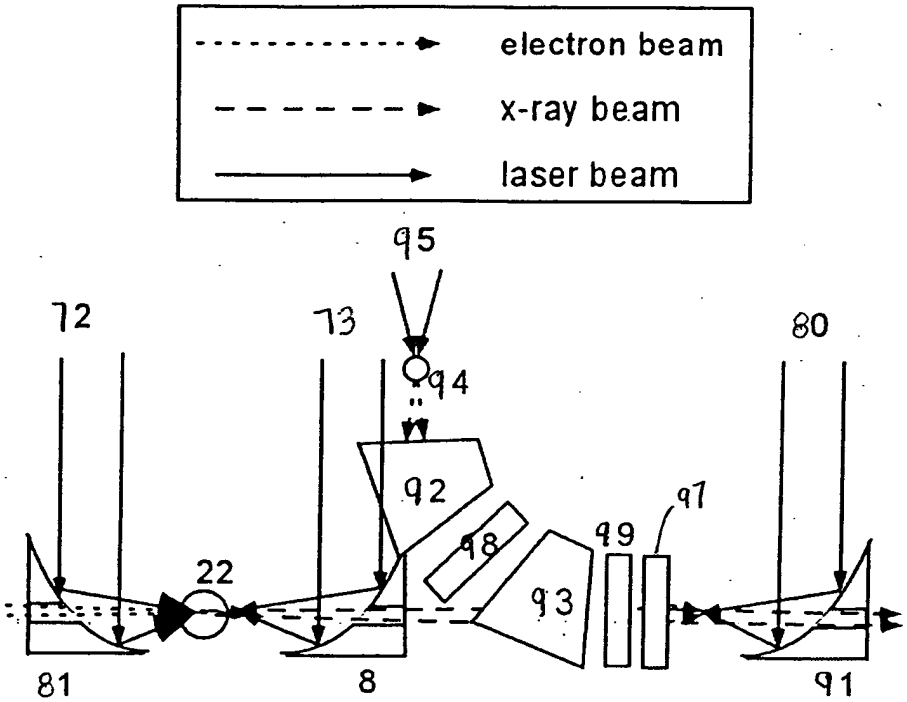



FIGURE 8. Oscillator-amplifier configuration. The components are the same as in Fig. 6, but a DQDQQ configuration of Fig. 5 is used to reduce the energy spread of, and image, the electrons.




| | |
|---|---|
| 72 seeding pump laser | 98 quadrupole magnet |
| 73 amplifier pump laser | 8 parabolic mirror |
| 92 sector magnet | 22 seeding stage gas jet |
| 93 sector magnet | 80 2nd stage pump laser |
| 81 parabolic mirror | 91 parabolic mirror |
| 95 2nd stage electron pump laser | 99 quadrupole magnet |
| | 97 quadrupole magnet |
| | 94 2nd stage gas jet |

1st stage

FIGURE 9. Dual amplifier configuration. A second amplifier stage is added, in which a second electron beam and a second pump laser are used, after the seeding stage and the first amplifier of Fig. 6.

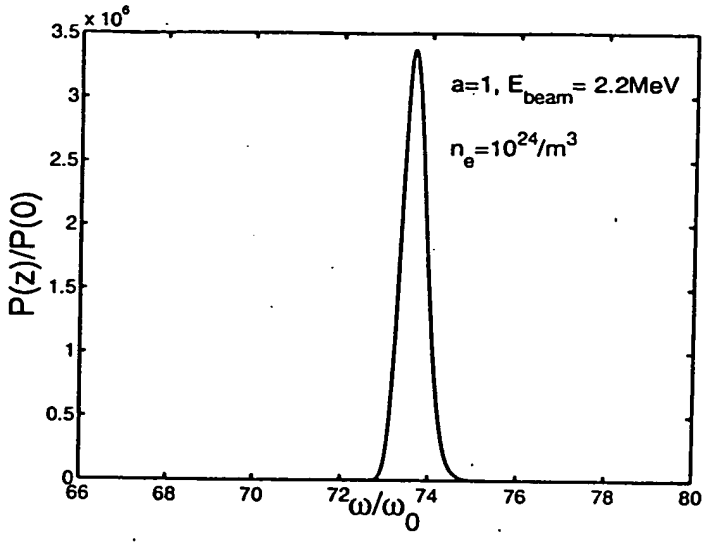



FIGURE 10. Exponential gain in XUV regime.

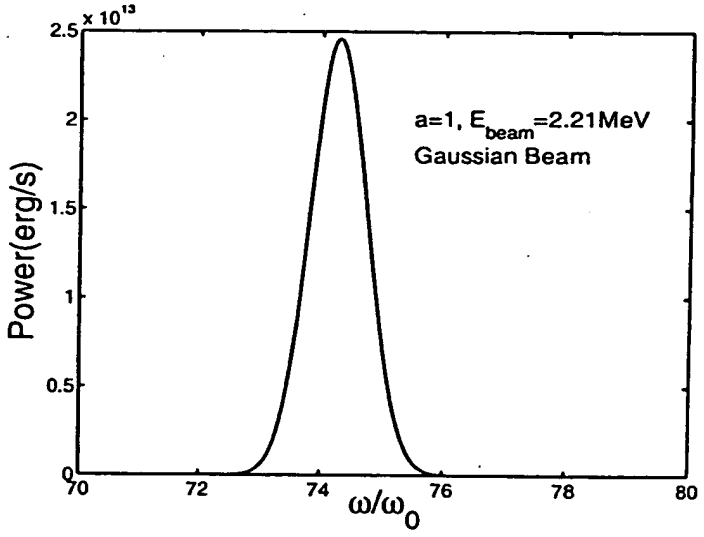



FIGURE 11. Incoherent XUV source.

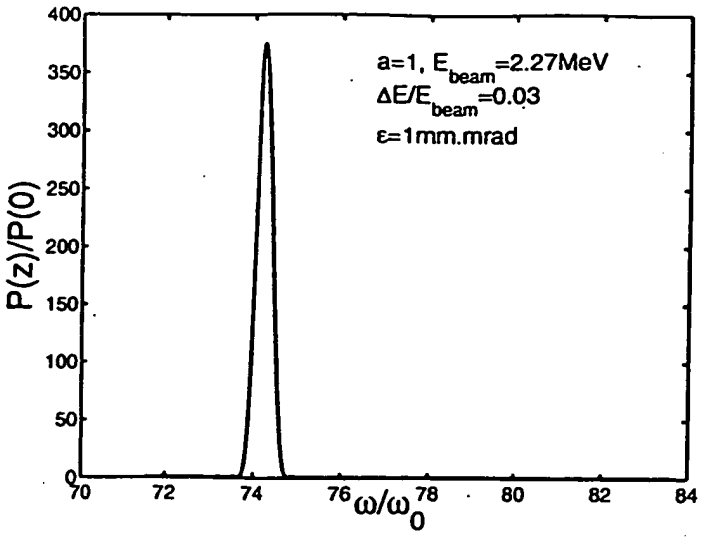



FIGURE 12. Collective gain with finite energy spread and transverse emittance.

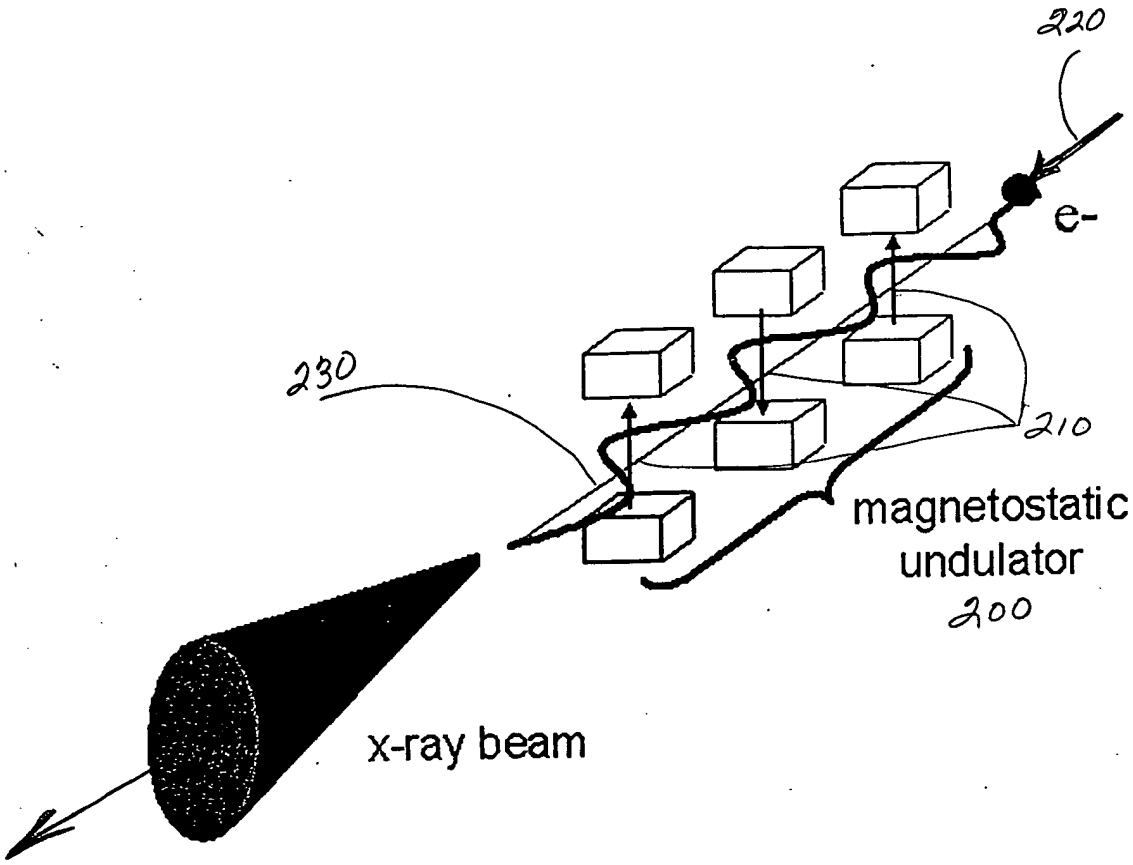



FIGURE 13.